

Polar Cap Boundary Layer Waves: Location, Interplanetary Dependence and Nature

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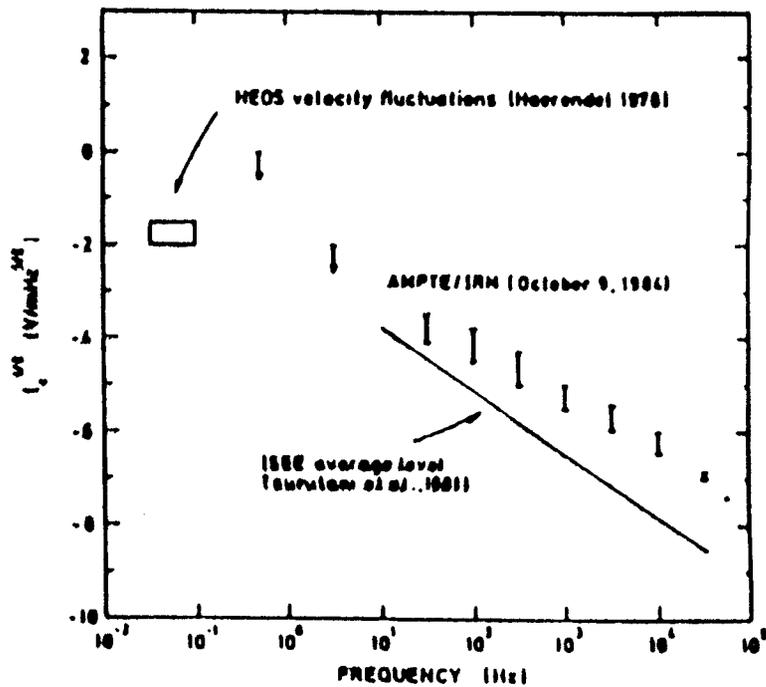
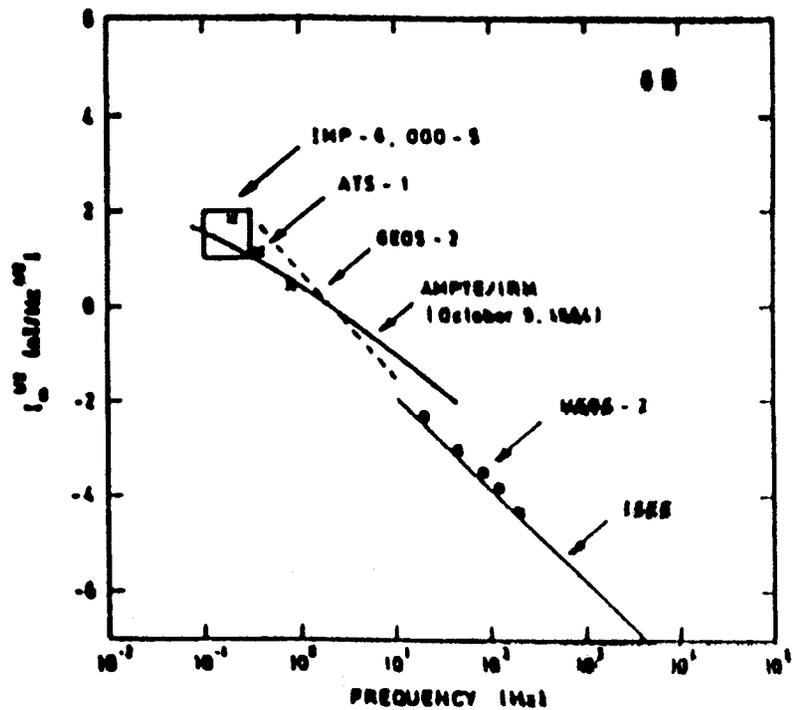
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

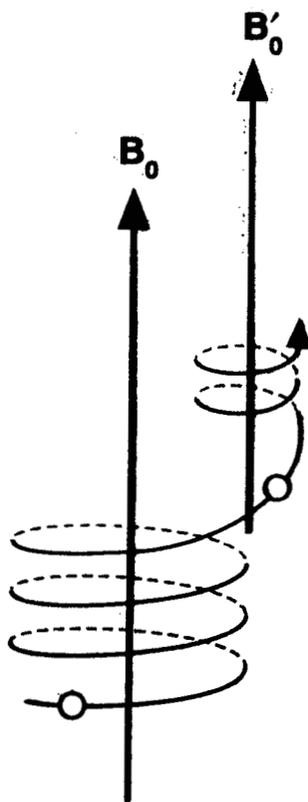
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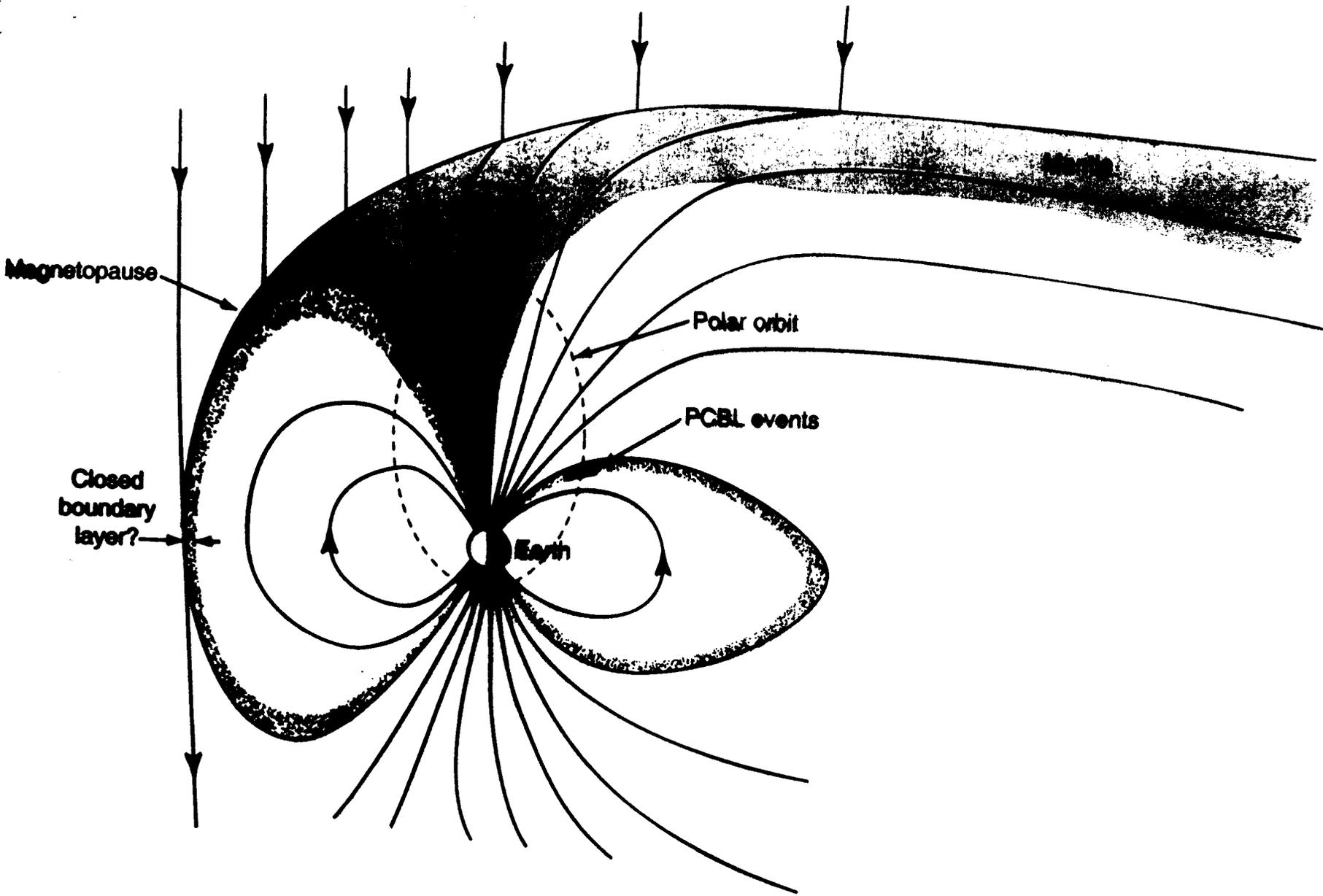
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Polar Cap Boundary Layer waves are ELF/ULF electric and magnetic waves detected on field lines just adjacent to the polar cap, thus their name. Waves are present at this location 96% of the time. The wave latitude-local time distribution is shown to be the same as that of the auroral oval. The most intense waves are detected coincident with the strongest magnetic field gradients (field-aligned currents). Local noon and midnight wave intensities are the greatest when the interplanetary magnetic field $B_z < 0$. Specific frequency bands of whistler mode-waves are identified: ~200 Hz, 1-2 kHz and ~5 kHz. Assuming resonant interactions, energies for electron and ion beams are derived. Two types of intense electric waves are present: solitary bipolar pulses (electron holes) and Langmuir waves. The PCBL waves are most likely a consequence of instabilities associated with auroral field-aligned currents. The currents have in turn been ascribed to be due to magnetospheric convection driven by the solar wind. One consequence of the presence of the waves at high altitudes is diffusion of magnetosheath plasma into the magnetosphere and magnetosphere plasma out into the magnetosheath.

Polar
Cap
Boundary
Layer

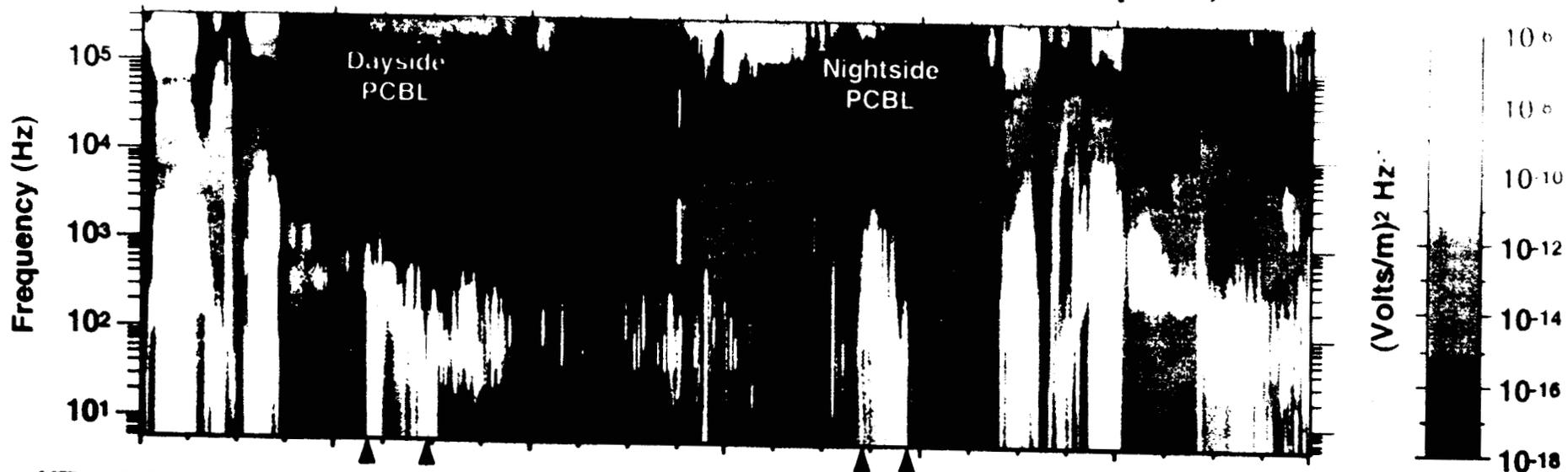






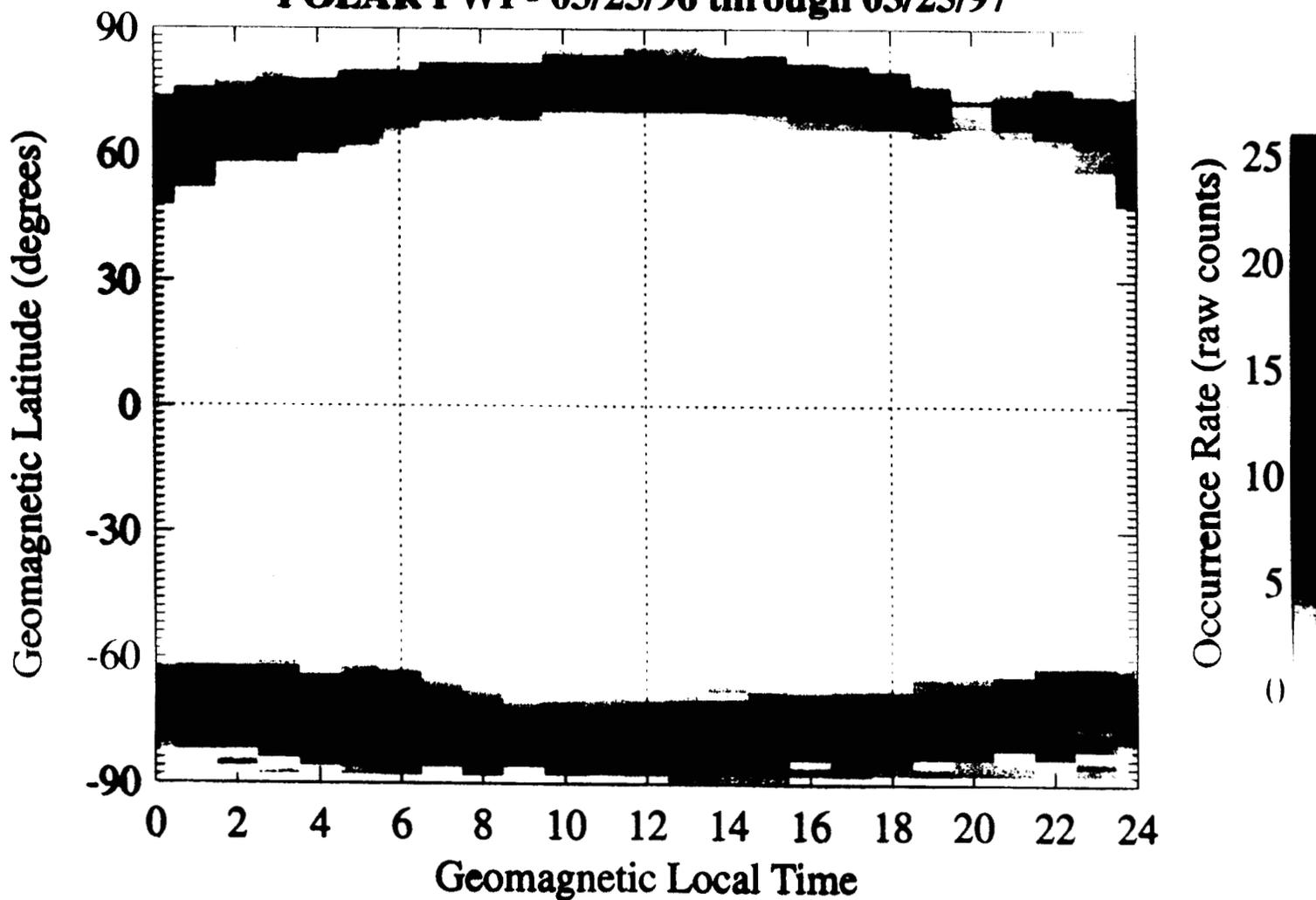
Polar PWI MCA E Eu

April 7, 1996



UT	00:00	04:00	08:00	12:00	16:00	20:00	00:00
R_E	4.302	4.980	8.398	8.755	6.257	2.568	7.521
λ_m	7.707	47.26	79.71	57.70	21.59	12.25	81.17
MLT	0.7827	12.71	17.56	23.02	0.3515	12.84	9.891
L	4.432	10.66	262.4	30.47	7.144	2.712	318.2

POLAR PWI - 03/25/96 through 03/25/97



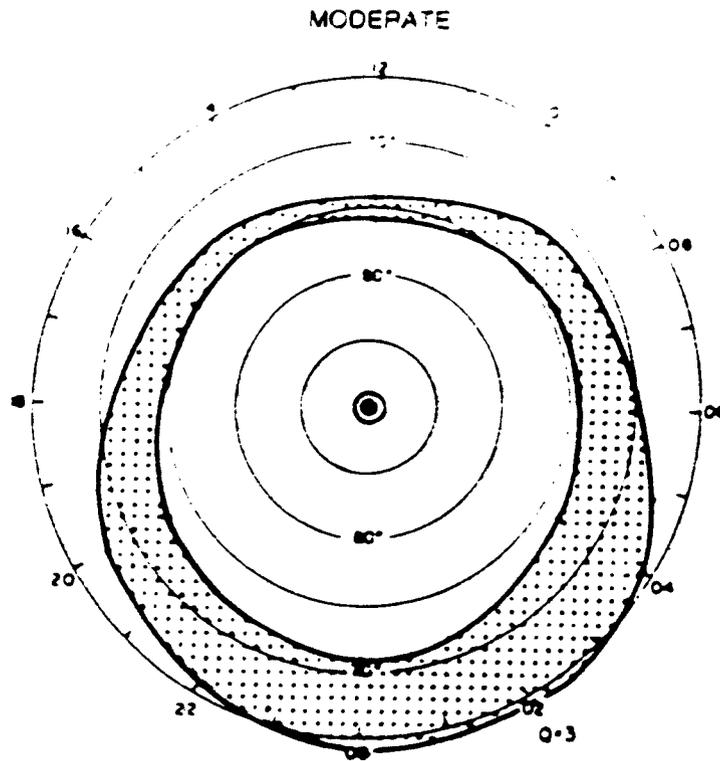
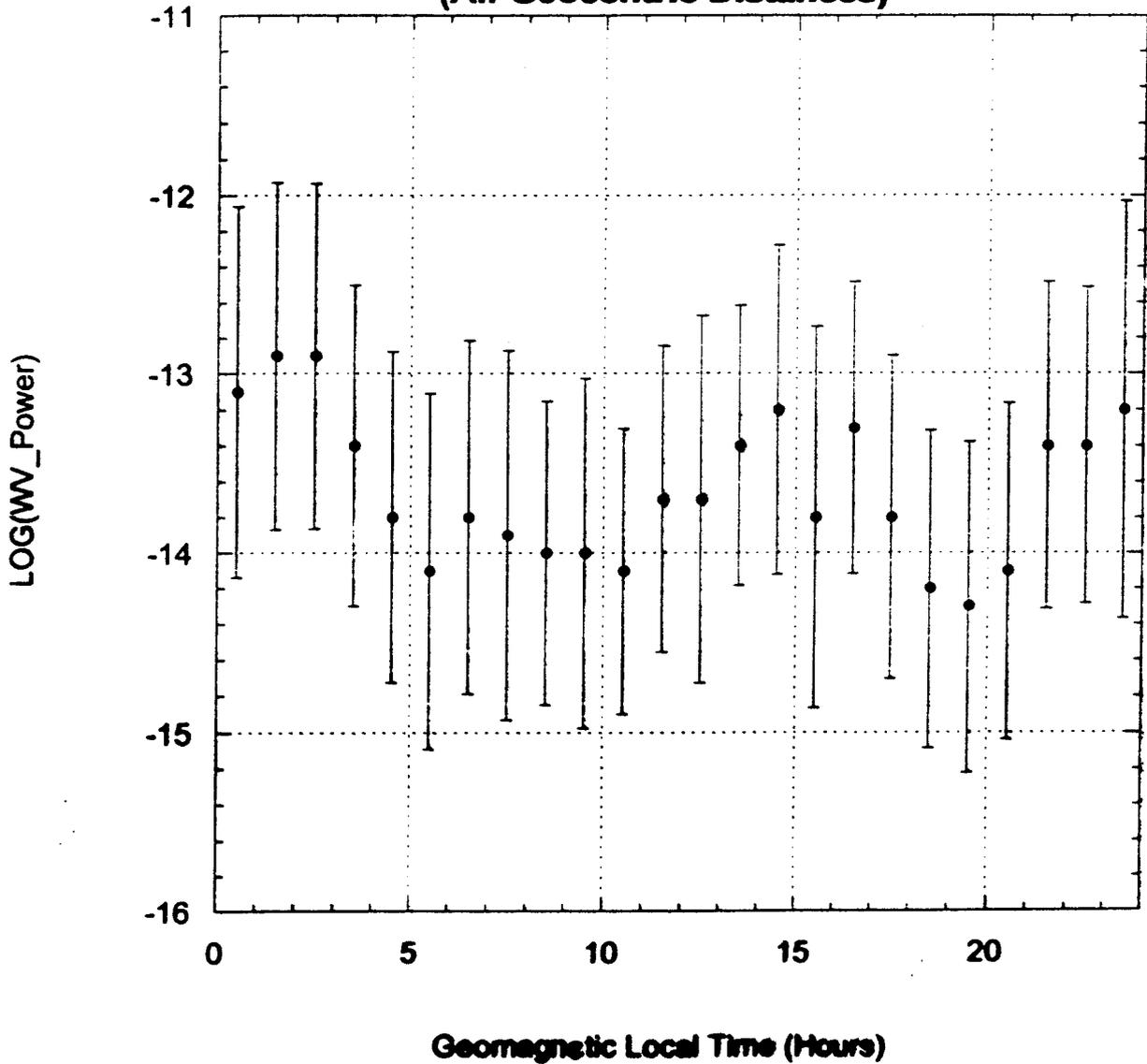
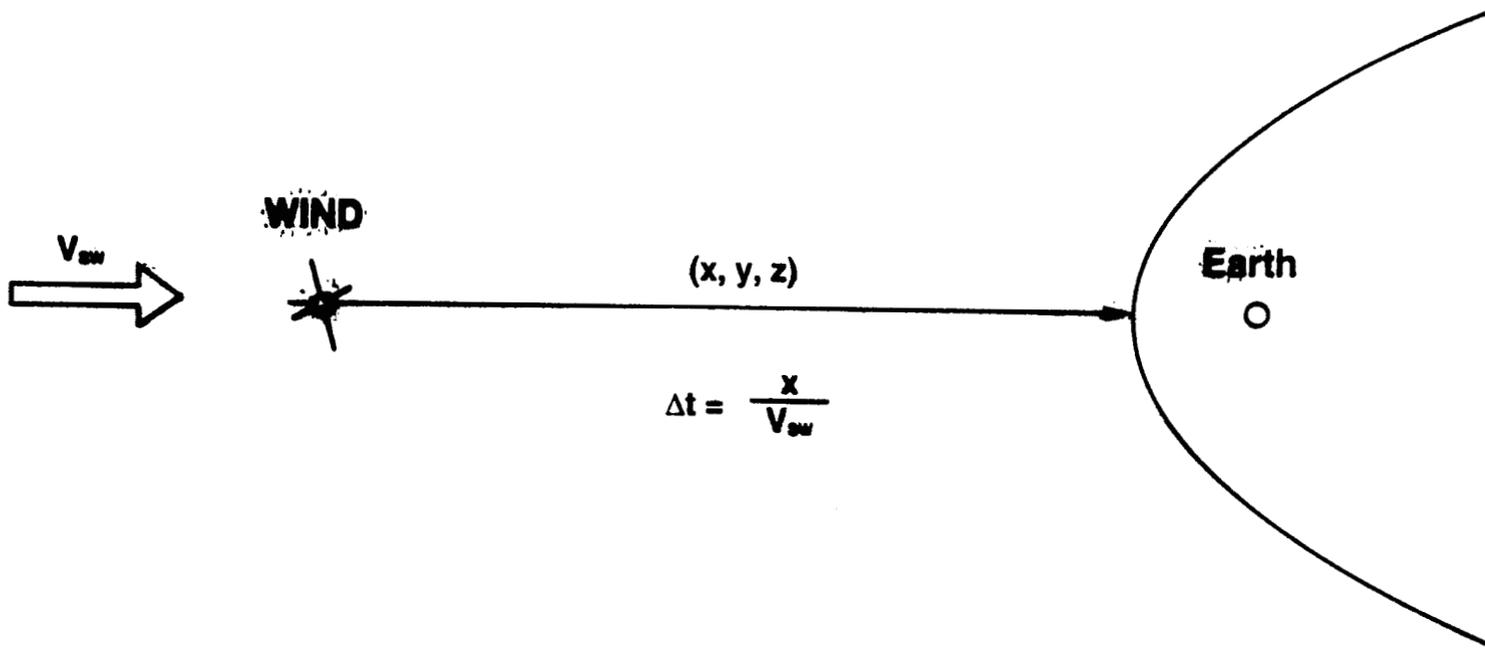


FIG. 14.8. Variation in the size of the auroral oval with activity. The shaded area represents the distribution of maximum auroral activity in the northern hemisphere. Coordinate system is corrected geomagnetic (CG) latitude and CG local time, and noon is at the top. (Adapted from Fel'dstein and Starkov, 1967.)

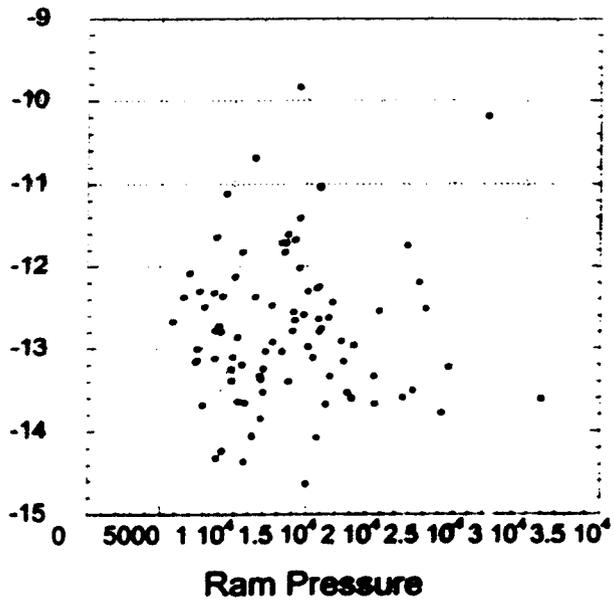
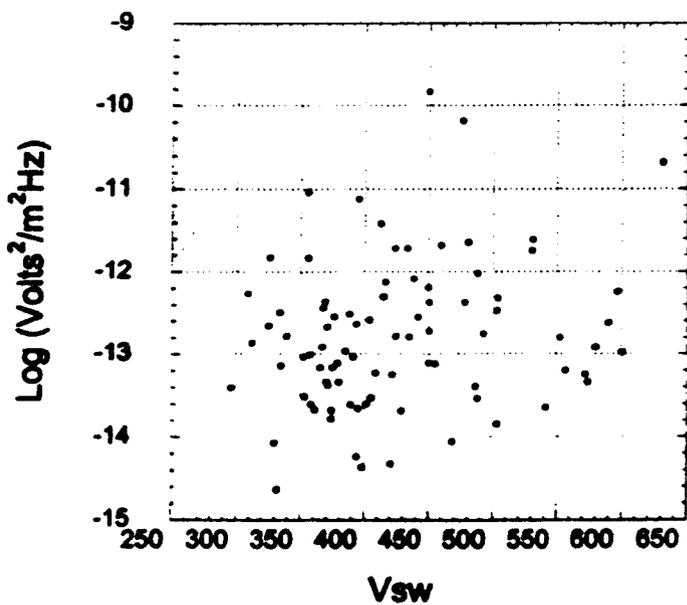
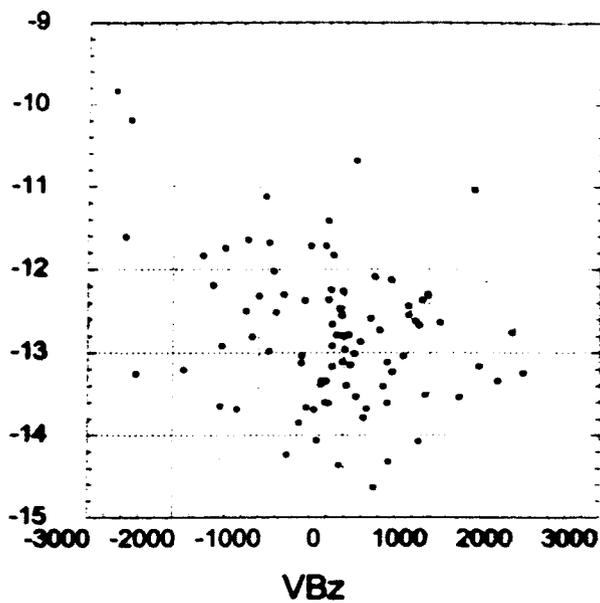
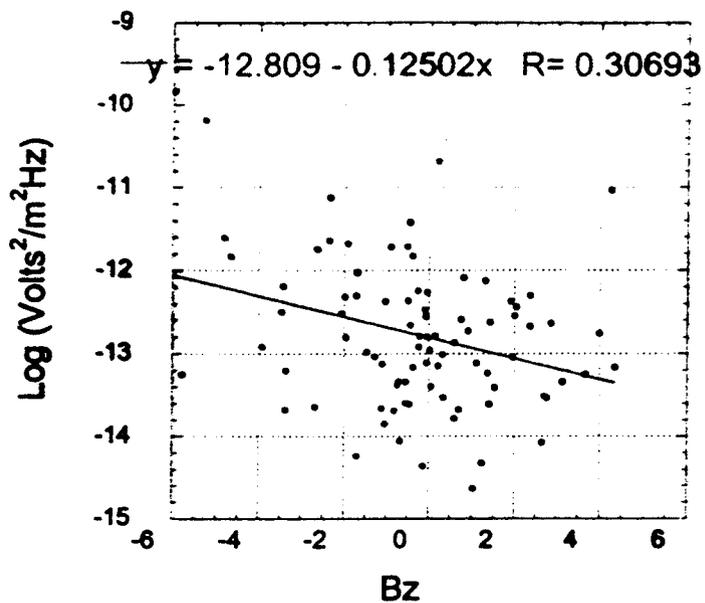
• LOG(WV_Power)

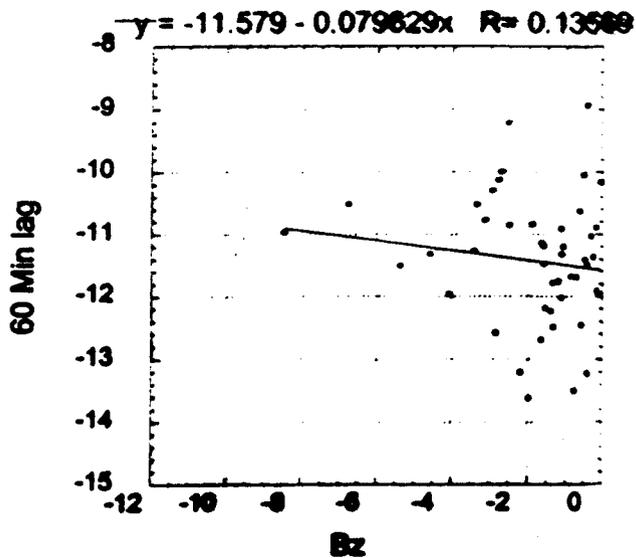
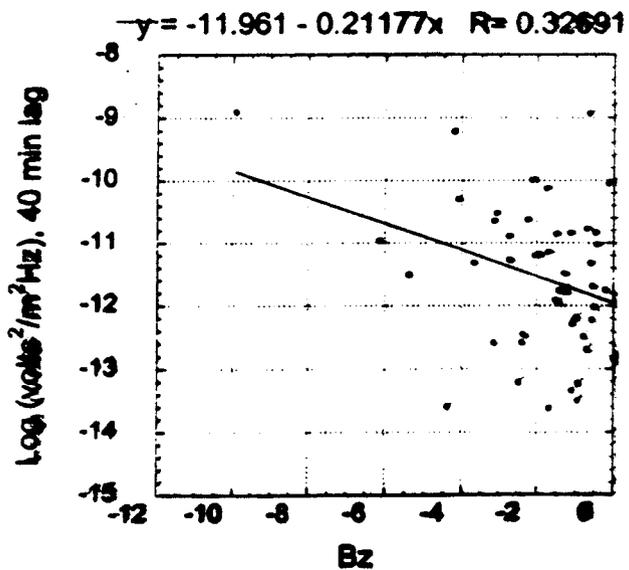
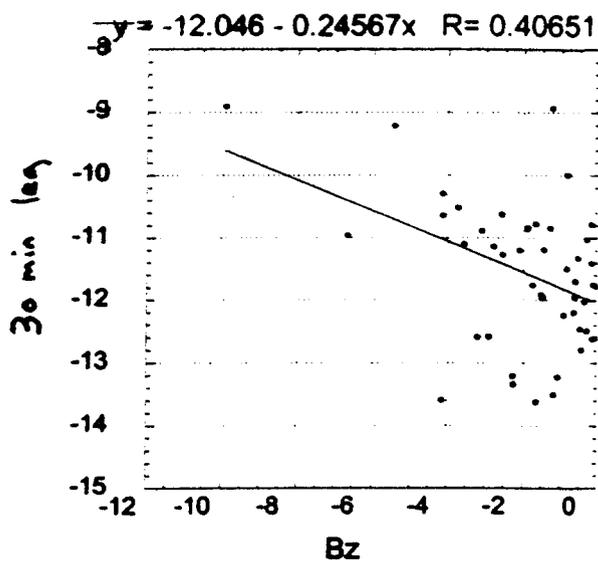
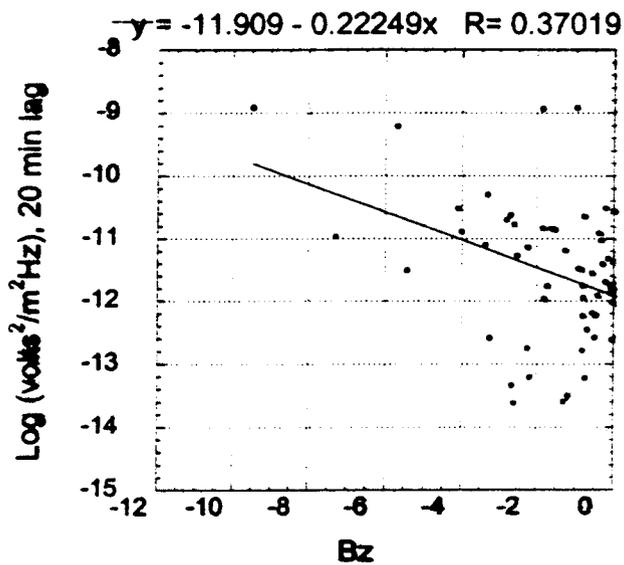
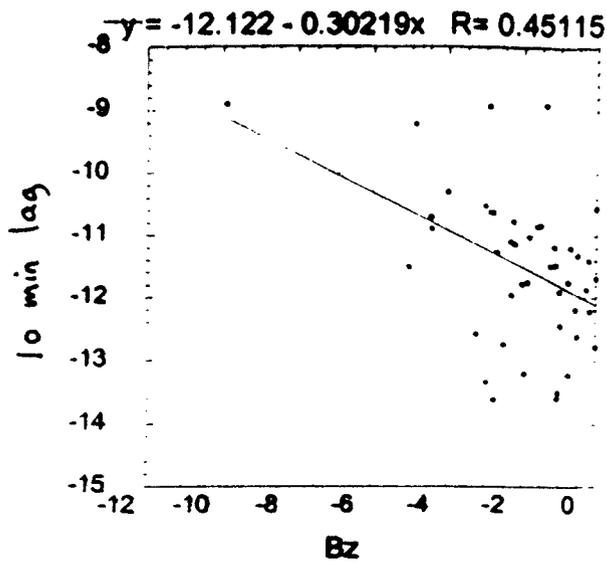
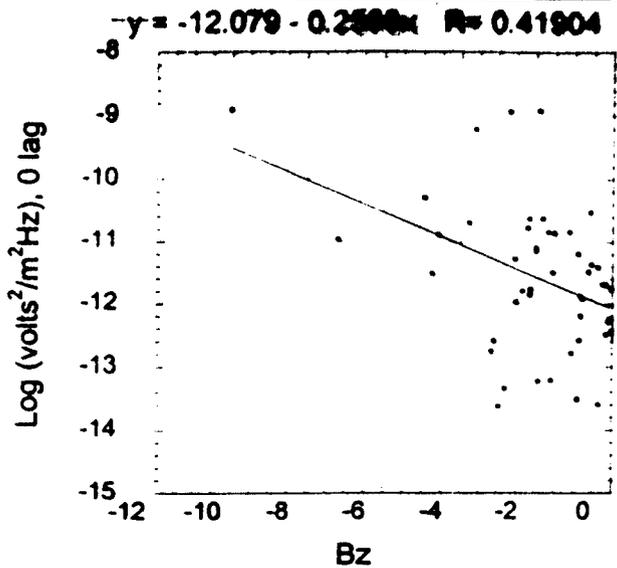
Log of Wave Power @ 3 kHz vs. GM Local Time
(All Geocentric Distances)



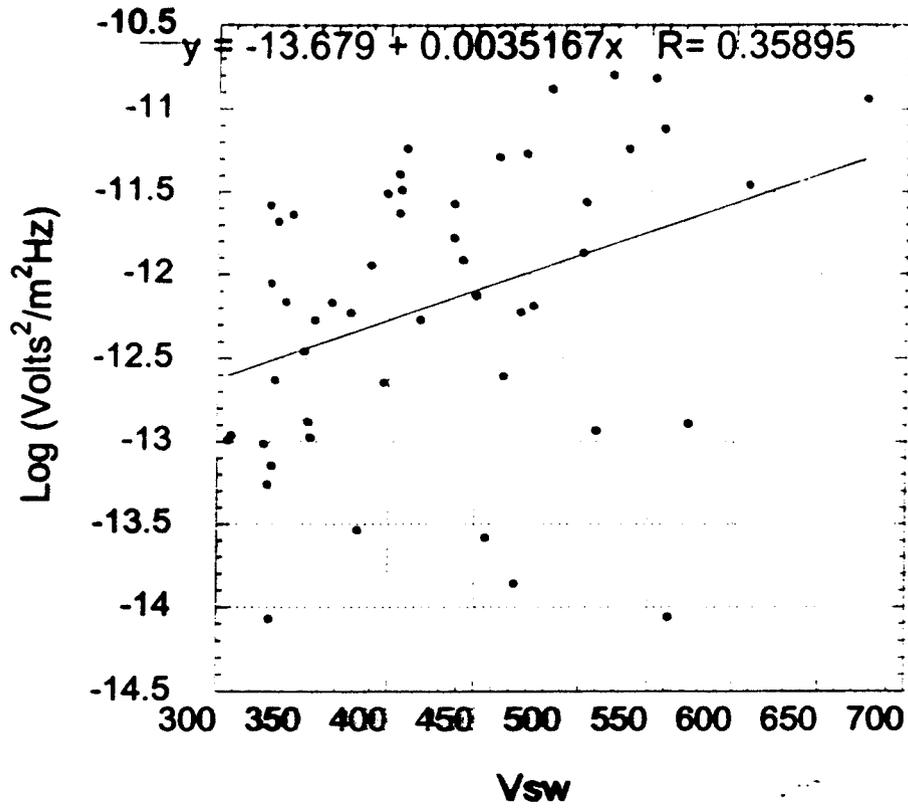


NOON (10-14 MLT) Electric Waves 562 Hz



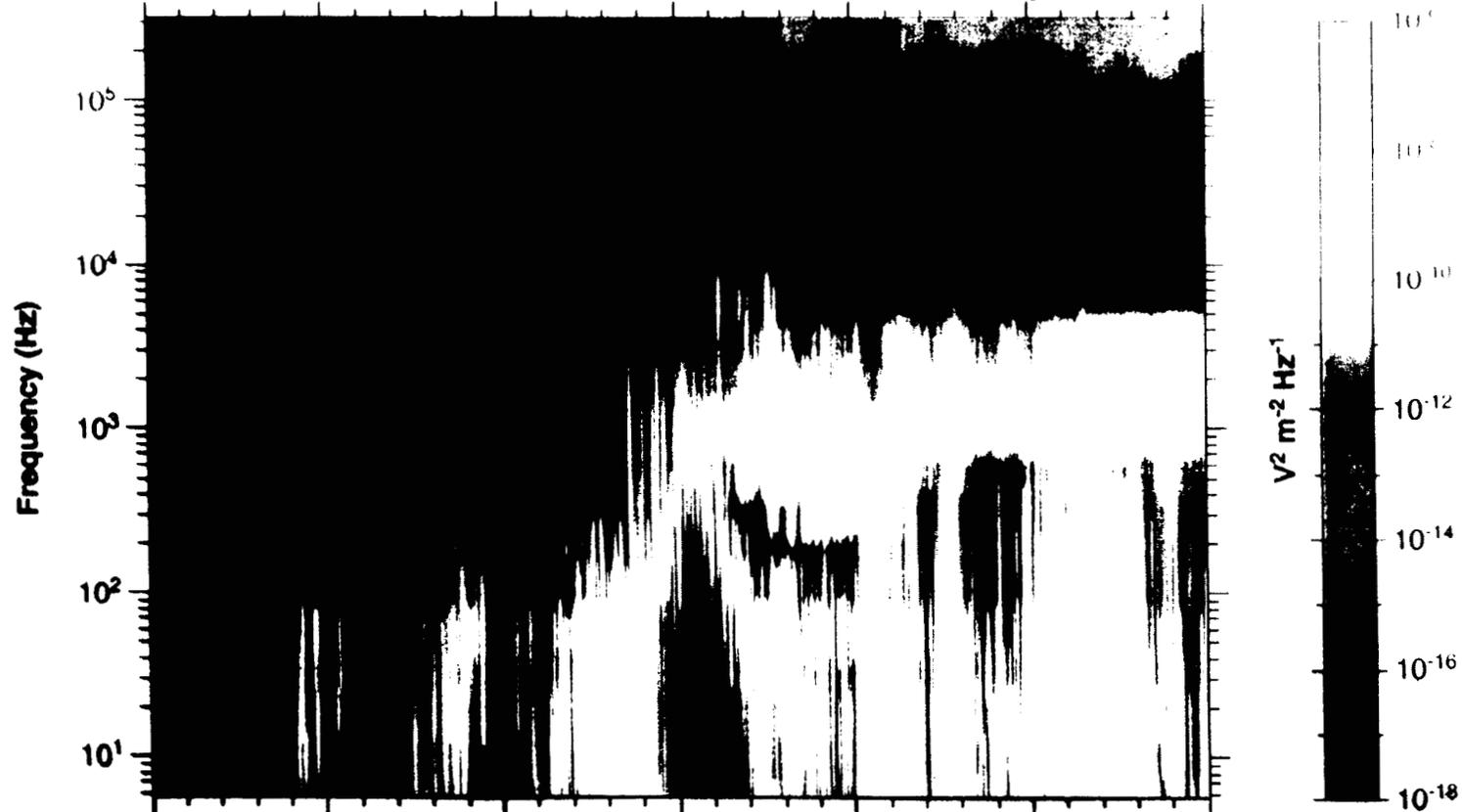


Dusk (16-20 MLT) Electric Waves 562 Hz



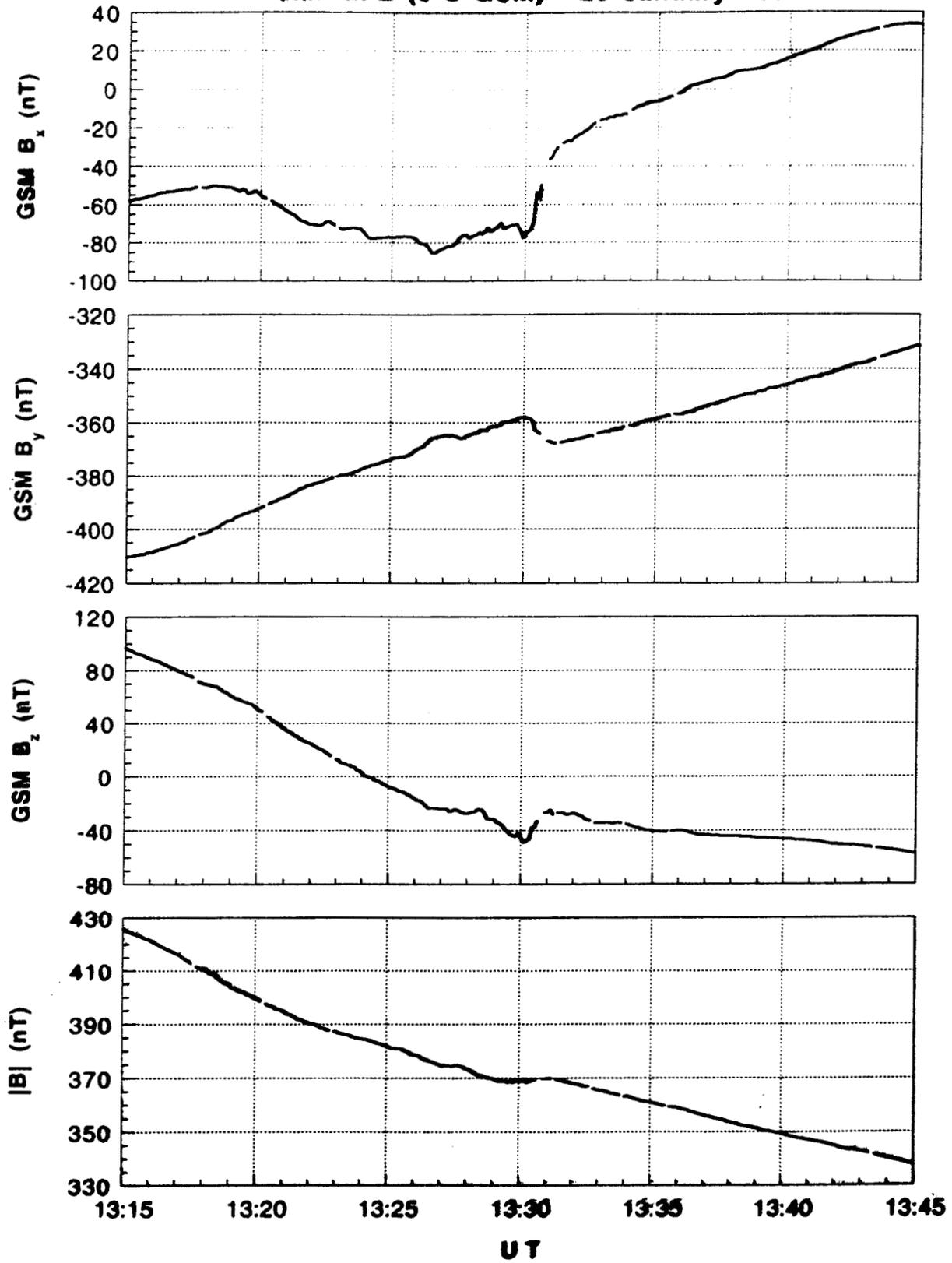
Polar PWI MCA-E Eu

January 26, 1997



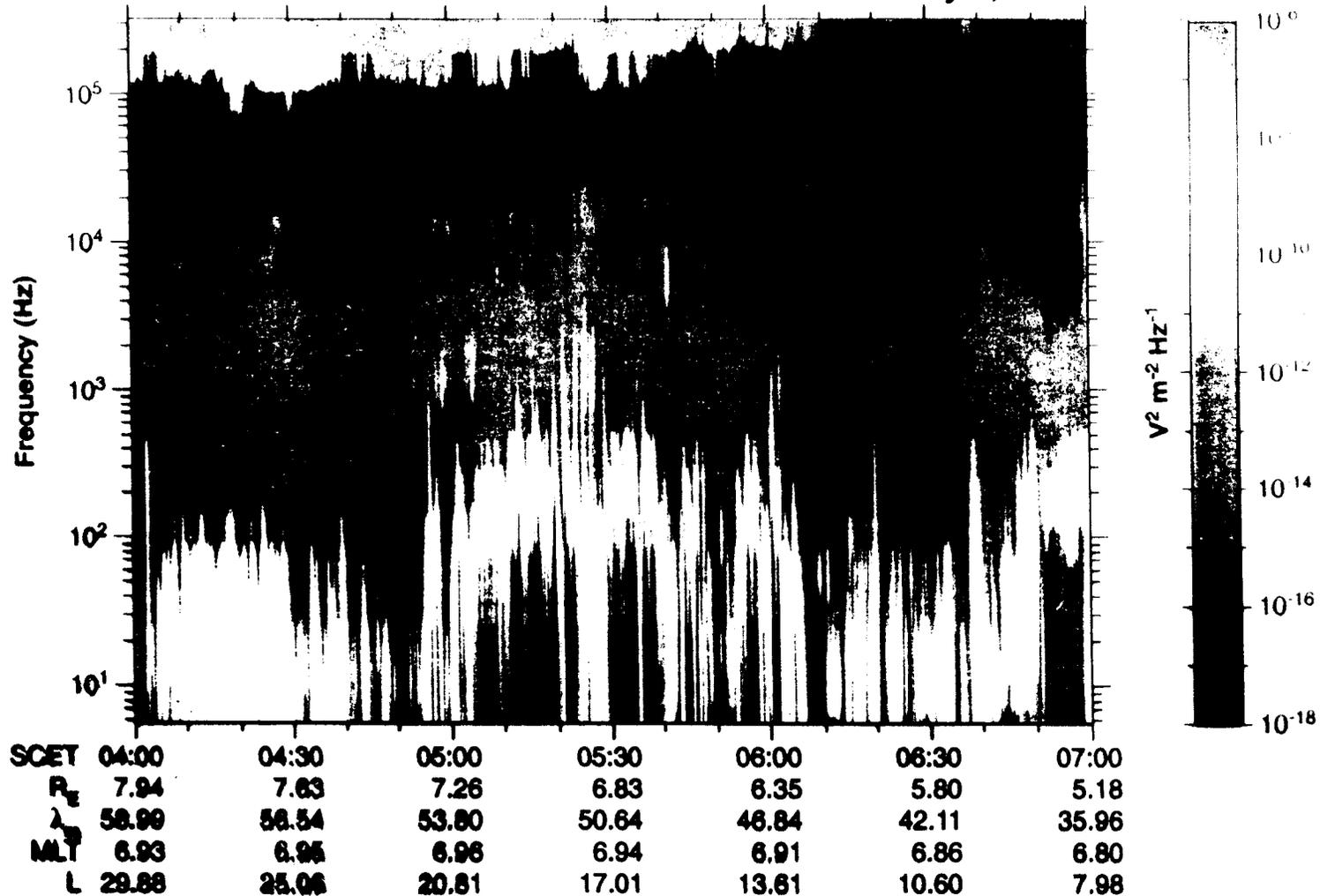
SCET	13:15	13:20	13:25	13:30	13:35	13:40	13:45
R _E	4.52	4.64	4.76	4.87	4.99	5.10	5.21
λ _E	26.36	28.26	30.08	31.82	33.48	35.07	36.60
MLT	17.52	17.55	17.59	17.62	17.66	17.69	17.73
L	5.60	5.95	6.32	6.72	7.14	7.58	8.05

Polar MFE (0 s GSM) - 26 January 1997

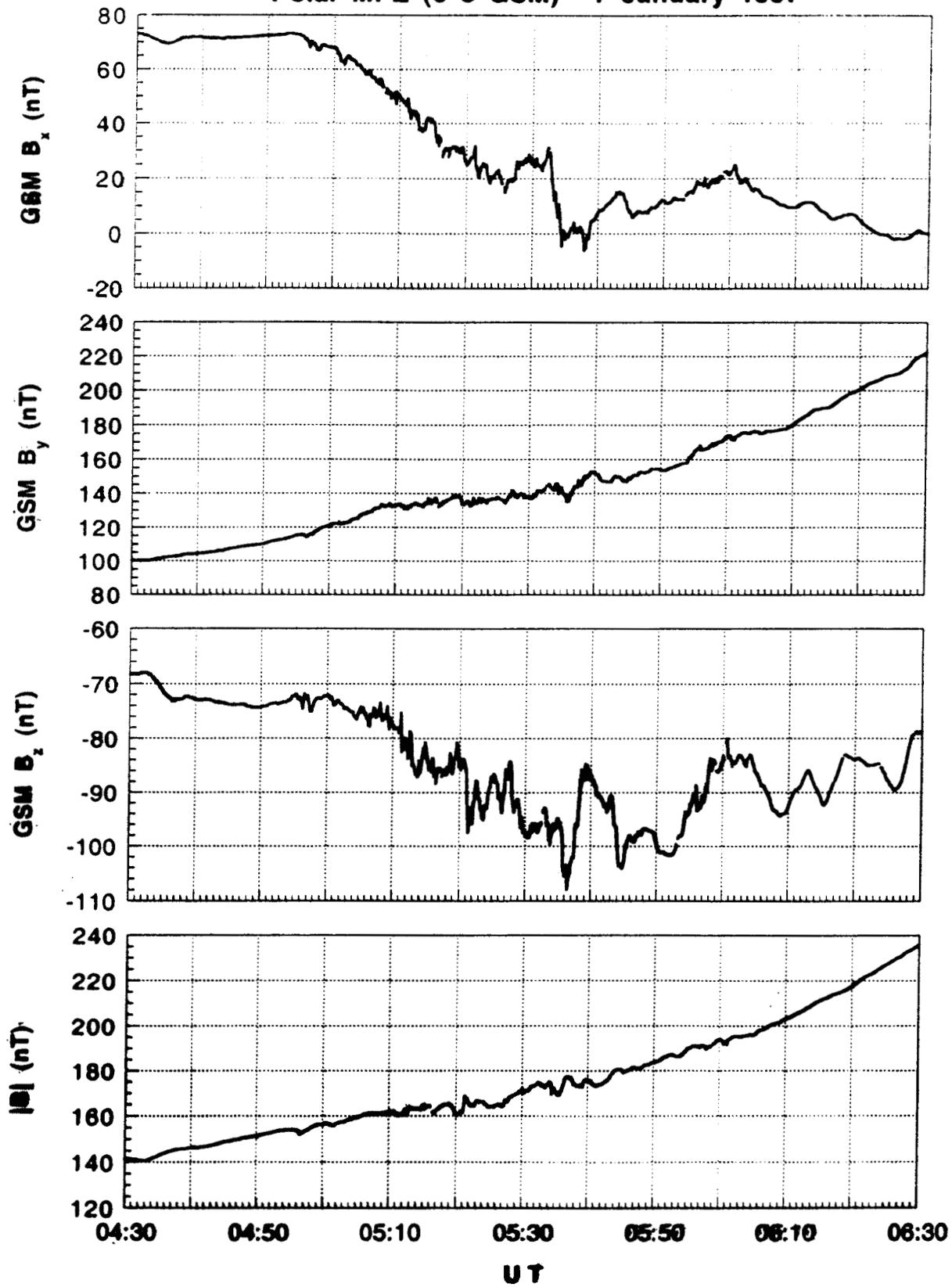


Polar PWI MCA-E Eu

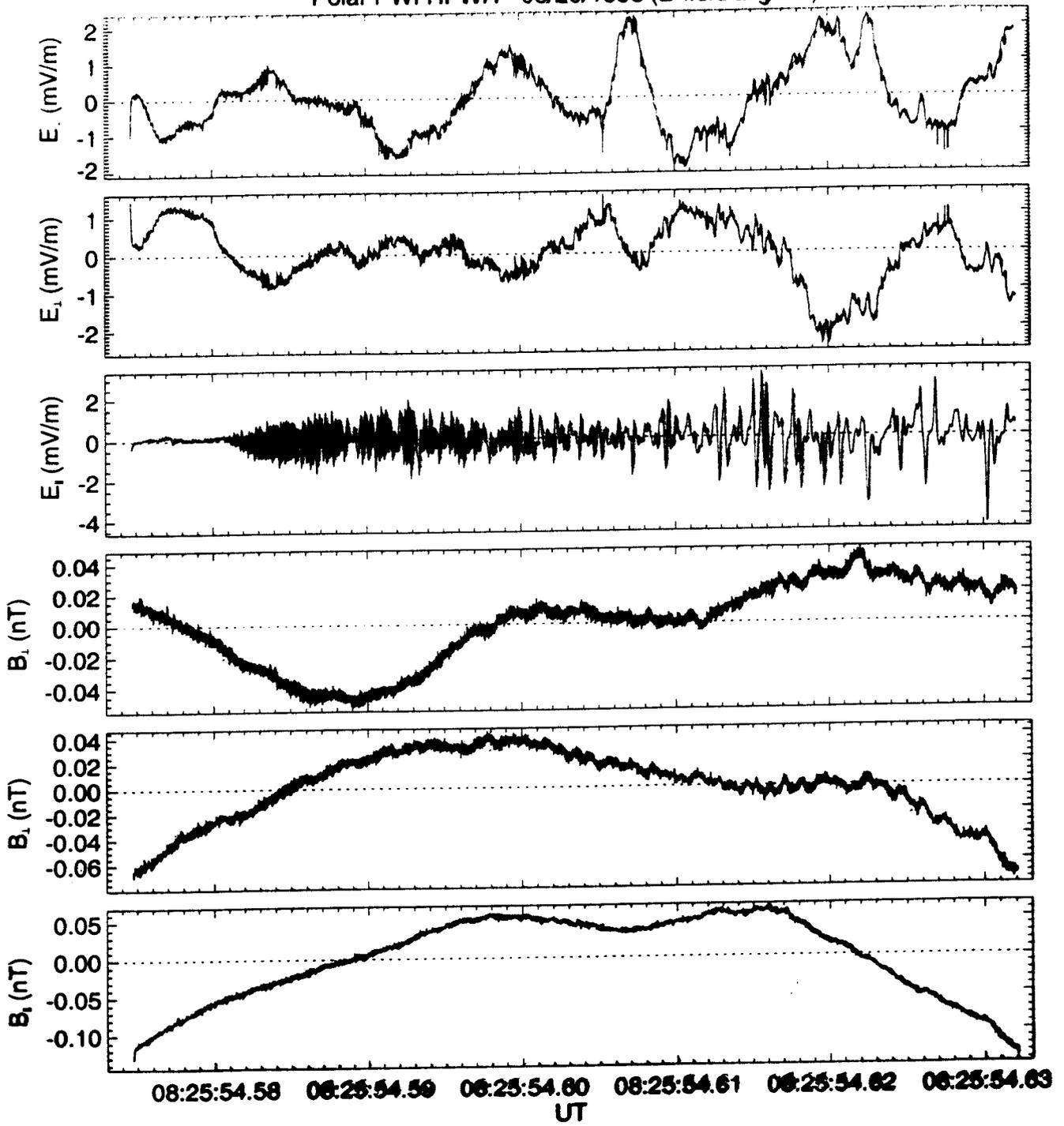
January 7, 1997



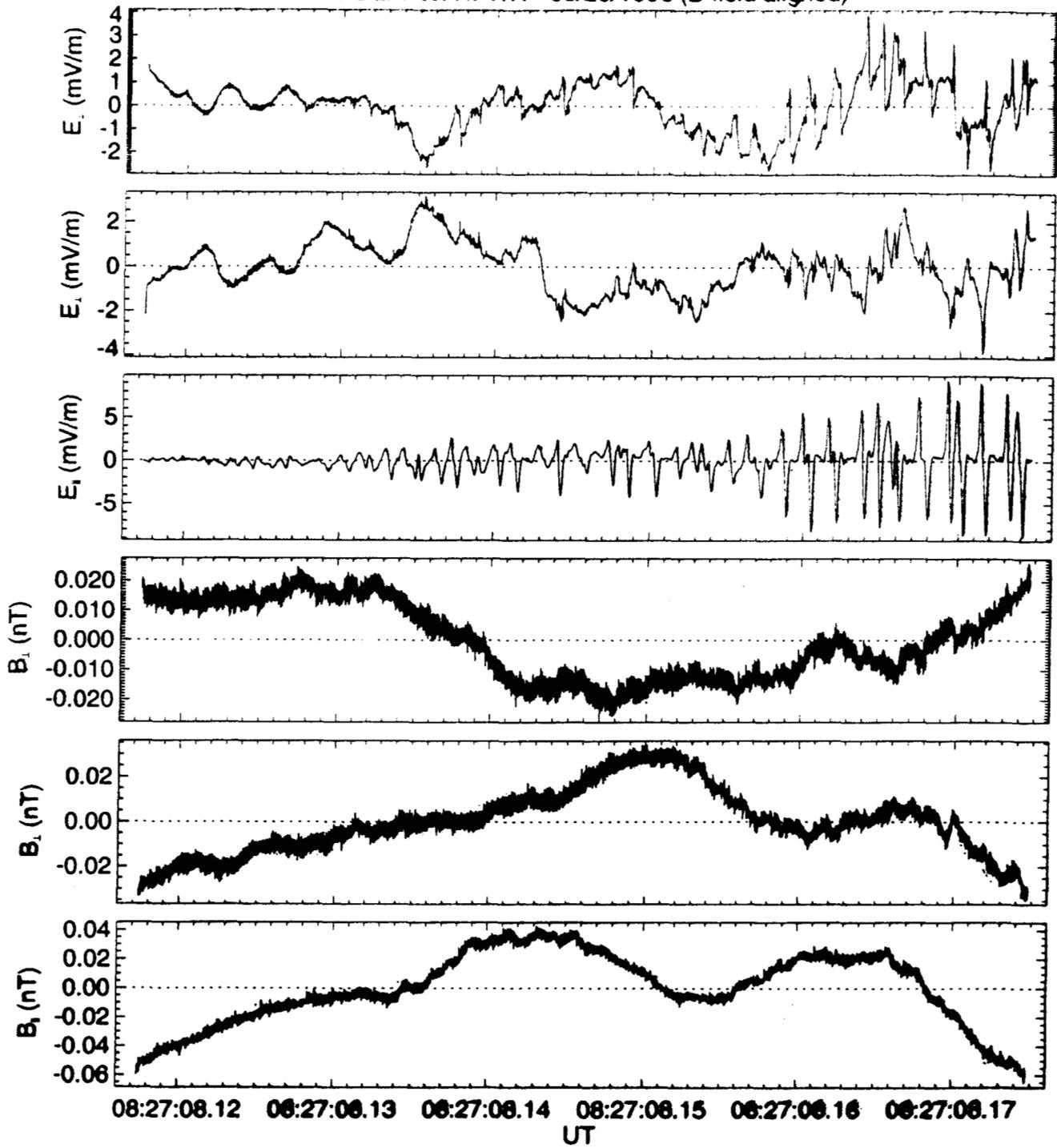
Polar MFE (6 s GSM) - 7 January 1997



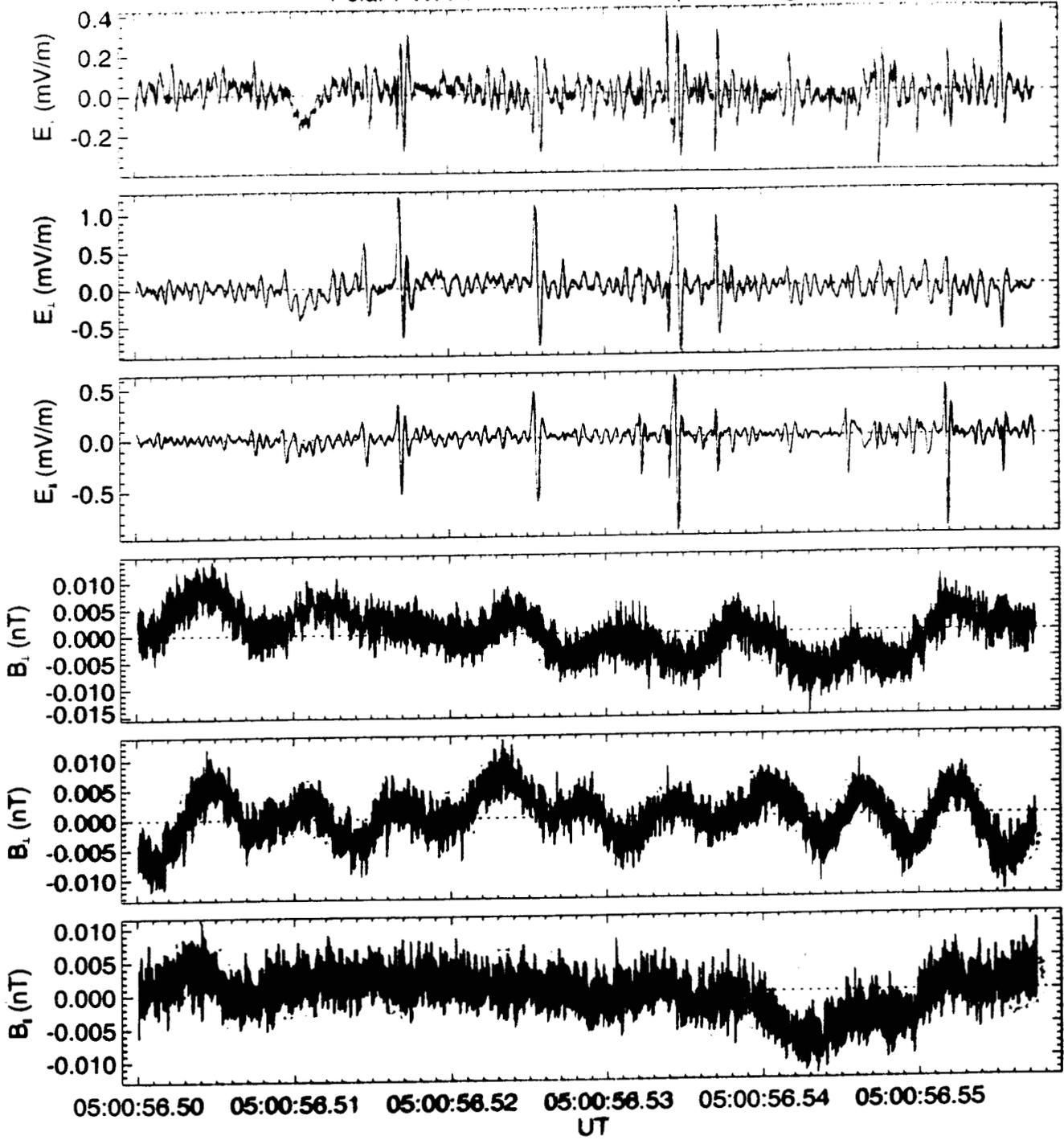
Polar PWI HFWR - 05/20/1996 (B-field aligned)

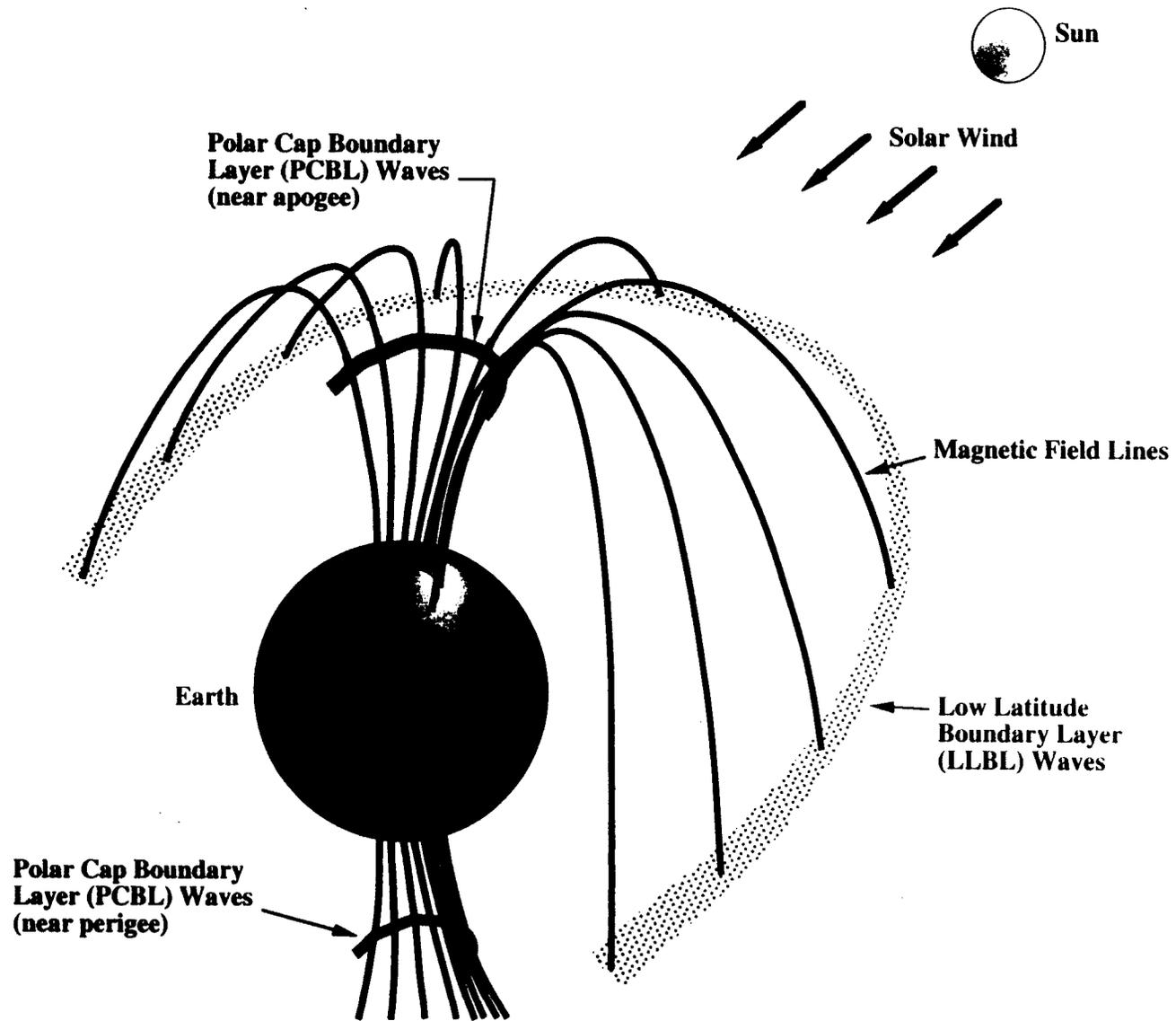


Polar PWI HFWR - 05/20/1996 (B-field aligned)



Polar PWI HFWR - 01/07/1997 (B-field aligned)





CONCLUSIONS

PCBL Waves

- Global, auroral zone phenomenon.
- Dayside waves enhanced when IMF $B_z < 0$, nightside enhanced when substorms occurring.
- Strongly related to field-aligned currents.

SUMMARY

~200 Hz Electromagnetic Waves

- Counter-streaming ~25 KeV electrons**

- ~ 45 KeV ion beams**

- ~ 1 keV ion beams generating left-hand mode waves with subsequent mode conversion**

1 to 2 kHz Electromagnetic Waves

- 1 keV electron beams**

5 kHz Electromagnetic Waves

- ~100 eV electron beams**

Bipolar, monopolar electrostatic pulses.

- electron holes**

A NEW VIEW OF THE BOUNDARY LAYER

- The PCBL and LLBL regions are dominated by ionospheric plasma.
- The near-ionosphere electric fields generate the particle beams that generate the PCBL/LLBL plasma waves.
- The LLBL plasma waves lead to cross-field diffusion of magnetospheric plasma into the magnetosheath and magnetospheric/solar wind plasma into the magnetosphere, e.g., it is a "viscous" interaction layer.